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A rapid entomological reconnaissance during the first Zika outbreak in Thiruvananthapuram city, Kerala, India

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Abstract

There was an outbreak of Zika virus in Thiruvananthapuram city of Kerala state, India in July 2021. In order to ascertain the prevalence and breeding pattern of the potential vectors, a study was conducted from 22 July 2021 to 27 July 2021. Breeding habitat surveys were conducted in seven localities in the city from where Zika cases were reported. House to house searches were conducted from mosquito breeding in 35-40 houses in each locality. Fourth instar larvae were identified using larval keys and later confirmed their identities after emergence. Lower instar larvae were reared in the laboratory and were identified after emergence using adult keys. Larval indices were calculated using WHO methods. Of the 280 houses surveyed mosquito breeding was encountered in 38 houses. Three *Aedes* species viz., *Ae. aegypti*, *Ae. albopictus* and *Ae. vittatus* were detected. *Ae. aegypti* and *Ae. albopictus* were breeding in 30.5% and 43.9% of the outdoor habitats and 56.0% and 16.0% of the indoor habitats respectively. The overall Container Index for (CI), Breteau Index (BI) and House Index (HI) for both species together were 56.07, 23.07 and 14.61 respectively. Two established urban Zika vectors viz., *Ae. aegypti* and *Ae. albopictus* were prevalent in the city with very high container indices. For the first time in the world, indoor flower vases used for money plant has been observed as an important breeding habitat of *Aedes* mosquitoes. Rapid elimination of the breeding habitats with community support is recommended to reduce the larval indices.

Keywords: Zika, *Aedes aegypti*, *Aedes albopictus*, Container Index, House index, Breteau index

1. Introduction

The history of Zika dates back to 1947, when a new virus was detected from a Rhesus monkey in Uganda, Africa, which was later named as Zika virus after the name of the forest in which the virus was isolated. The first incidence of the virus in humans was reported in 1952 from Nigeria^[1]. Although there were occasional outbreaks after the first outbreak in different parts of Africa and Asia, the disease was not considered a serious public health problem owing to its benign nature^[2]. However, the re-emerged Zika, starting with Yap Island, Micronesia in 2007 which spread to French Polynesia and several South American countries, appeared more virulent causing microcephaly in infants and Guillain Barre Syndrome in adults. This led World Health Organisation to declare Zika as a Public Health Emergency of International Concern (PHEC) on 1 February 2016, on the advice of an Emergency Committee of the International Health Regulations and of other experts^[3].

The first report of the re-emerged Zika in the WHO South-Eastern Region (WHO-SEAR) was in 2012 from Indonesia^[4]. In India serological evidence for the prevalence of Zika virus was available as far back as in 1952 with 33 samples out of 196 samples collected from six states turning positive. However, post re-emergence, Zika appeared in India for the first time during 2016-17. There were four cases reported from Gujarat and Tamil Nadu during that period^[5]. Subsequently, in 2018, there were two major outbreaks in Rajasthan and Madhya Pradesh with 153 and 130 confirmed cases respectively^[5].

On 8th July 2021 media reported a case of Zika in Thiruvananthapuram, the capital city of Kerala state. The patient was a 24 year old pregnant woman admitted in a private hospital in the city on 28th June 2021. She delivered a healthy baby on 7th July 2021, a day before the confirmation of Zika. In the subsequent days more cases were reported from different parts of the city. In reply to the starred question No. 275 by the member of Parliament Shri Hibi Eden

(available in public domain), the minister of health and family welfare, Government of India stated that there were 65 cases of Zika in Kerala as on 2nd August 2021. 61 cases were reported from Thiruvananthapuram city and another four cases from three cities outside the city. These four cases had histories of travel to Thiruvananthapuram.

Against this background we had designed a study to investigate the prevalence and pattern of breeding of potential vectors of Zika in the city. The study was carried out from 22 July 2021 to 27 July 2021.

2. Materials and Methods

2.1. Study area: The study was carried out in Thiruvananthapuram, the capital city of the South Indian state Kerala. The city has an area of 214 KM² and a population of 957, 730 (2011 Census).

2.2. Larval survey: Larval surveys were conducted in seven localities in the city, viz., Nanthancode, Kannanmoola, Karamana, Chakkai, Medical college, Thycaud and Nalanchira, from where Zika cases were reported. 35-40 houses were surveyed in each locality. The number of houses surveyed varied according to the size of the premises. Overall 260 premises were surveyed. Intensive searches were conducted indoor and outdoor for larval habitats, especially containers and tanks. Only those containers/ tanks with water were considered as breeding habitats. From small containers, entire water with larvae were emptied in to plastic containers. From large tanks and barrels, five samples each were collected using 300 ml dippers.

2.3. Identification: Fourth instar larvae were identified with larval keys [6]. Early instar larvae were reared in the laboratory and the adults were identified using adult keys [7].

2.4. Data analysis: Container index, House index and Breteau index were calculated as recommended by World Health Organisation [8].

3. Results and Discussion

3.1. Habitat diversity: Eight types of breeding habitats viz., barrels/drums, plastic tanks, cement tanks, coconut shells, discarded tyres, flower pots and minor plastic containers were encountered outdoors. Plastic tanks (28.0%), flower pots (24.4%) and minor plastic containers (23.2%) were the major breeding habitats, which together formed 75.6% of the total habitats (Table-1). The indoor breeding habitats encountered were flower vases/ pots used for keeping money plants or lucky bamboos, drip trays of refrigerators and coolers, and leaf axil. Flower pots/ vases (60%) was the topmost habitat (Table -2).

3.2. Mosquito breeding: Three *Aedes* species viz., *Ae. aegypti*, *Ae. albopictus* and *Ae. vittatus* were found breeding both indoor and outdoor. Of the 82 outdoor habitats *Ae. aegypti* bred alone in 10 habitats and in combination with *Ae. albopictus* in 15 habitats. *Ae. albopictus* was found breeding alone in 21 habitats and *Ae. vittatus* in one habitat. Four habitats had breeding of non-Aedine mosquitoes. There were 25 indoor habitats, of which 10 had *Aedes aegypti* breeding. Co-breeding of *Ae. aegypti* and *Ae. albopictus* was found in four habitats. *Ae. vittatus* breeding was restricted to a single habitat. While 25 (30.5%) outdoor habitats had breeding of *Ae. aegypti*, 36 (43.9%) habitats had *Ae. albopictus*. Among 25 indoor habitats 14 (56%) had *Ae. aegypti* and 4 (16%) had *Ae. albopictus* breeding. Overall percentage breeding of *Aedes aegypti*, *Ae. albopictus* and *Ae. vittatus* were 36.4, 37.3 and 1.87 respectively.

Table 1: Breeding pattern of *Aedes* mosquitoes in outdoor habitats in Thiruvananthapuram city.

Breeding Habitats	Total habitats surveyed (%)	Positive Habitats				
		<i>Ae. aegypti</i>	<i>Ae. albopictus</i>	<i>Ae. aegypti</i> + <i>Ae. albopictus</i>	<i>Ae. vittatus</i>	Non- <i>Aedes</i> species
Barrels/ drums	6 (7.3)		4			
Plastic tanks	23 (28.0)	3		6	1	2
Cement tanks	3 (3.7)		2	1		
Coconut shells	5 (6.1)		3			
Discarded tyres	6 (7.3)	3	1			
Flower pots	20 (24.4)	1	10	4		
Minor plastic containers	19 (23.2)	3	1	4		2
Total	82	10	21	15	1	4

Table 2: Breeding pattern of *Aedes* mosquitoes in indoor habitats in Thiruvananthapuram city

Breeding Habitats	Total habitats surveyed	Positive Habitats				
		<i>Ae. aegypti</i>	<i>Ae. albopictus</i>	<i>Ae. aegypti</i> + <i>Ae. albopictus</i>	<i>Ae. vittatus</i>	Non- <i>Aedes</i> species
Flower vases /pots	15 (60.0)	6		3	1	
Drip trays of refrigerators/ coolers	9 (36.0)	3		1		
Leaf axils	1 (4.0)	1				
Total	25	10		4	1	0

3.3. Larval indices: Mosquito breeding was detected in 38 houses out of 260 houses surveyed. Number of positive habitats for *Ae. aegypti* and *Ae. albopictus* together was 60 out of 107 habitats surveyed. The overall Container Index

(CI), Breteau Index (BI) and House Index (HI) for both species together were 56.07, 23.07 and 14.61 respectively ((Figure-1).

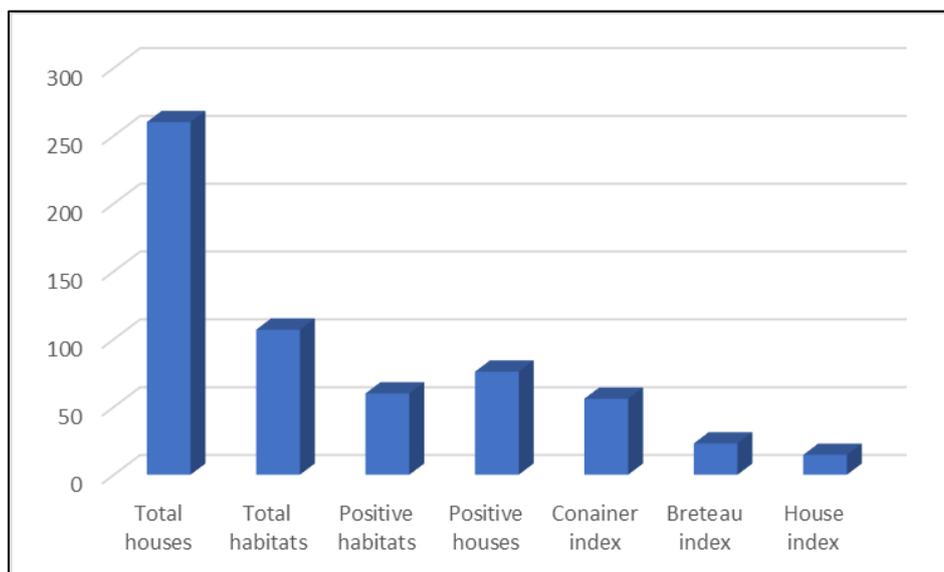


Fig 1: Breeding status of *Ae. aegypti* and *Ae. albopictus* in Thiruvananthapuram

Zika virus has two different life cycles, urban cycle and sylvian cycle. Major vectors in the urban cycles in Asia are *Ae. aegypti* and *Ae. albopictus*, with the former playing the dominant role [9]. Both species were prevalent in the study area. *Ae. aegypti* was the predominant indoor species occupying 56% of the breeding habitats surveyed. In the outdoor habitats, both species were prevalent with *Ae. albopictus* (43.9%) exhibiting moderate edge over *Ae. aegypti* (30.5%). Another interesting observation was the co-breeding of these two species both outdoor (18.3%) and indoor (16.0%).

Immediately after the report of the first case of Zika in Thiruvananthapuram city, an intensive drive for the elimination of *Aedes* breeding was launched in the city under the aegis of the Directorate of health Services, Government of Kerala. Our study started after a gap of exactly two weeks. Hence, the quantity of breeding habitats and the extent of *Aedes* breeding did not represent the real picture which would have existed prior to 8th June 2021, the day when the first case was reported. Nevertheless, there were epidemiologically significant number of breeding habitats as well as *Aedes* breeding supported by those habitats as revealed by the high larval indices (CI =56.07, BI =23.07 and HI=14.61). This has exposed the lacunae in the habitat elimination drive. Ward level planning led by the elected representatives of the municipal corporation and forming sub-ward level teams for house to house search for breeding habitats and their elimination are likely to reduce the indices rapidly and effectively. Except for cement tanks, all other positive breeding habitats observed in the study area are easily disposable. Since minor plastic containers formed a significant contributor to breeding habitats, anti-plastic drive would reap collateral benefits. Cement tanks could either be demolished or larvivorous fishes can be introduced.

Another interesting observation was vector breeding in flower pots/ flower vases indoors. Refrigerators and coolers have been widely reported as important contributors for the proliferation of *Ae. aegypti* from many parts of India [10, 11]. Flower pots/vases were used for keeping either money plant (*Epipremnum aureum*) or Lucky bamboo (*Dracaena sanderiana*). While growing money plants is believed to improve financial status of the family, lucky bamboos are

used in the Feng shui, a traditional Chinese practice, again for improving the quality of life. Though outdoor flower vases with money plants were reported to harbour *Ae. aegypti* and *Ae. albopictus* in Dhaka city, Bangladesh, their indoor prevalence has not been reported so far [12]. International trade in lucky bamboo was reported as means for the dispersal of the invasive mosquito *Aedes albopictus* on several occasions [13, 14]. However, their role as breeding habitats in the context of mosquito-borne diseases have not been reported from anywhere in the world.

Kerala, being a state with very high population density and intense inter-city travelling the possibility of spread of the disease to other cities is very high. As stated in the introduction, four cases originated from the city were reported from two other cities in the state. Rapid reconnaissance and elimination of vector breeding would reduce larval indices as reported from other Zika outbreak areas in India [15].

4. Conclusion

Although the first outbreak of Zika in India was reported during 2016-17, its emergence in Kerala was in July 2021. Though stray cases were reported from Tamil Nadu earlier, this was the major outbreak in South India, with 65 cases. Though Zika has not been associated with mortality, it should not be ignored as a trivial disease owing its ability to cause microcephaly in foetuses during pregnancy and Guillain Barre syndrome in adults. The present study showed the prevalence of two established vectors viz., *Aedes aegypti* and *Aedes albopictus* in Thiruvananthapuram city. They were found breeding in outdoor as well as indoor habitats. While *Aedes aegypti* was the predominant breeder indoors and *Aedes albopictus* was dominant outdoors. With well organised source reduction strategies involving the community could prevent future outbreaks in the city and elsewhere in Kerala.

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